TITLE

IMPROVED CABLE BOLT

FIELD OF THE INVENTION

The present invention relates to an improved cable bolt, in particular to an improved cable bolt adapted for use in coal mining.

BACKGROUND OF THE INVENTION

Cable bolts are steel tendons inserted into bore holes in a rock surface to stabilise the rock surface against collapse. In hardrock mining, the whole length of the tendon is grouted, and a plate is attached to the tendon adjacent to the rock surface. The tendon is then stressed; the plate bears upon the rock surface and thereby stabilises the rock surface.

Tendons typically comprise a plurality of steel strands wound together to form the tendon. It is known to provide multi-strand cable bolts that are formed with bulbs or expanded portions in order to increase the surface area of the tendon in contact with the grout to more securely embed the tendon in the grout. The bulbs or expanded portions thus increase the radial confinement of the tendon within the borehole.

In coal mining, where any movement of the rock surface is undesirable, an end portion of the tendon disposed innermost in the bore hole is secured therein by spinning the end portion in resin, attaching a resin dam to an opposing end of the spun end portion, and allowing the resin to cure. The remaining portion of the tendon disposed in the borehole is then tensioned to immediately stabilise the rock surface. The bore hole can then be grouted safely a short time later. In the meantime, the rock surface is stabilised against collapse before grouting commences or during the grout curing period.

When multi-strand cable bolts provided with bulbs or expanded portions are used to stabilise a rock surface of a coal mine, as described above, the bulbs or expanded portions tend to collapse under the load placed on the cable bolt when the tendon is tensioned to stabilise the rock surface. This type of multi-strand cable bolt is thus rendered ineffective as an anchoring means for coal mine rock surfaces, as the collapsed bulbs do not afford sufficient surface area to bond with the grout and the tendon "stretches" or lengthens as the bulbs collapse.

The present invention attempts to overcome at least in part some of the aforementioned disadvantages.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the present invention there is provided an improved cable bolt comprising a tendon composed of a plurality of strands, the tendon having a plurality of bulbous portions, wherein all the strands in each bulbous portion are spaced apart from one another substantially around the periphery of each bulbous portion, and a plurality of rigid elements, wherein the bulbous portions house the rigid elements, such that there is a minimal clearance between an outermost surface of the rigid element and a broadest part of a cavity of the bulbous portion.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a view of a cable bolt in accordance with the present invention; and

Figure 2 is an upper perspective view of a section taken along the line 2-2 of Figure 1.

DESCRIPTION OF THE INVENTION

Referring to the Figures, wherein like numerals and symbols refer to like parts throughout, there is shown a cable bolt 10 comprising a steel tendon 12. The tendon 12 is composed of a plurality of outer strands 14 helically wound around a centre strand 15 to form the tendon 12. As shown, there are six outer strands 14 wound around the centre strand 15. The tendon 12 has a plurality of bulbous portions 16 spaced apart from one another along the length of the tendon 12.

The portions of the strands 14 and 15, in the bulbous portions 16, are spaced apart from each other around the circumference of the bulbous portions 16, as shown. The section line 2-2 has been taken through the broadest part of the bulbous portion 16. As seen in Figure 2, the centre strand 15 is displaced away from the centre of the tendon 12. Typically, the bulbous portion 16 has a bulb diameter substantially as large as the diameter of the smallest tube through which the cable bolt 10 will pass. The bulb periphery is indicated by the broken lines, marked 17 in Figure 2. The outer strands 14 and the centre strand 15 are all located adjacent and within the bulb periphery 17.

The bulbous portion 16 houses a rigid element 20 within a cavity 18 defined by the outer strands 14 and the centre strand 15. Preferably, the rigid element 20 is a solid sphere, such as a steel ball bearing. It is envisaged that there will be minimal clearance between the outermost surface 22 of the rigid element 20 and the broadest part of the cavity 18 of the bulbous portion 16. Typically, the minimal clearance will range from 0.2 mm to 3 mm.

The rigid element 20 is inserted into the bulbous portion 16 after the bulbous portion 16 has been formed. Typically, two of the strands 14, 15 are prised apart from one

another by inserting a wedge member into the cavity 18 of the bulbous portion 16 between two of the strands 14, 15. The rigid element 20 is then inserted into the cavity 18 through a gap defined by the prised apart strands 14, 15. A rod member may be used to retain the rigid member 20 in the cavity 18 while the wedge member is retracted from between the prised apart strands 14, 15. When the wedge member is retracted the inherent tension in the prised apart strands 14, 15 encourages the strands 14, 15 to return to their original configuration in the bulbous portion 16. The rod member is then also retracted from the cavity 18 through the strands 14, 15, leaving the rigid member 20 encaged in the cavity 18 of the bulbous portion 16.

It will be appreciated that the bulb diameter of the bulbous portion 16 can vary according to the number and diameter of the strands 14, 15 used to form the tendon 12, and may be selected to suit the type of rock face in which the cable bolt 10 is intended to be inserted. For example, the bulb diameter may vary from 30 mm to 60 mm, but may be larger depending on the diameter of the strands 14, 15, the tendon 12, and the requirements of the application. Furthermore, the cable bolt 10 can be formed wherein the bulb diameter of specific bulb portions 16 may vary along the length of the cable bolt 10.

Accordingly, the size of the rigid element 20 housed in the cavity 18 of the bulbous portion 16 may be selected such that there is minimal clearance between the outermost surface 22 of the rigid element 20 and the broadest part of the cavity 18 of the bulbous portion 16.

The bulb frequency is defined as the distance between bulbous portions 16 along the length of the cable bolt 10. The bulb frequency will vary and be selected to suit the type of rock face in which the cable bolt 10 is intended to be inserted. For example,

in hard rock mining the bulb frequency can be up to one bulbous portion 16 per metre, whereas in coal mining, where a very stiff cable bolt 10 is required, the bulb frequency can be up to one bulbous portion 16 per 250 mm.

Furthermore, it will be appreciated that the bulb frequency can vary along the length of the cable bolt 10.

The cable bolt 10 is also provided with a breather tube, for egress of air out of the borehole when grout is being pumped into the borehole. The breather tube is securely fastened adjacent to, and along the whole length of, the cable bolt 10 by suitable fastening means, such as electrical conduit clips.

In use, the cable bolt 10 is inserted into a bore hole drilled in a rock face. An end portion of the cable bolt 10 disposed innermost in the bore hole is secured therein by spinning the end portion in resin, attaching a resin dam to an opposing end of the spun end portion, and then allowing the resin to cure.

The resin is adapted to encase at least the innermost bulbous portions 16 in the borehole such that typically the innermost 2 to 4 bulbous portions 16 are encased in resin.

At an outermost end of the spun portion of the cable bolt 10 there is provided a resin dam comprising a seal of silicon which typically encases an adjacent bulbous portion 16 of larger diameter than the innermost bulbous portions 16 encased in resin. The large bulbous portion 16 is also typically shrinkwrapped in polyethylene plastic. The purpose of the large bulbous portion 16 is to prevent resin being forced down and out of the borehole during the "spinning" operation, thereby acting as a bung or seal.

Alternatively, the cable bolt 10 may be provided with a flange and complimentary washer, a clamp, or a swage with complimentary washer to prevent the resin from

being forced down the hole. The remaining portion of the cable bolt disposed in the borehole is then tensioned to immediately stabilise the rock surface.

When the cable bolt 10 is tensioned or stressed, the load placed on the bulbous portion 16 will be resisted by the rigid element 20 housed within the bulbous portion 16, thereby preventing the bulbous portion 16 from collapsing.

The borehole is then filled with grout, which is allowed to cure and solidify. The grout contacts a greater surface area of the strands 14 in use, as hereinbefore described. The cable bolt 10 is thereby firmly embedded in the grout.

In the meantime, the rock surface is stabilised against collapse before grouting commences or during the grout curing period.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.